



# Fuel Cell Program

ONR Program Code 33

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## At a Glance

### What is it?

■ The Office of Naval Research (ONR) Fuel Cell Program is a focused basic and applied research program designed to address the science and technology gaps in current fuel cell power systems that limit their ability to meet the unique aspects of future electrical power needs for naval platforms and systems.

### How does it work?

■ This program invests in a broad range of basic and applied research specifically focused on enabling a wide variety of affordable fuel cell systems capable of meeting the demanding weight, volume, power quality and energy density needs of future naval power systems intended to operate under extremely stressing conditions. Additionally, technology demonstrations at the component and system level are pursued as part of ONR's advanced technology development investments.

### What will it accomplish?

■ The fuel cell systems and components enabled by this program will significantly improve power generation capabilities within the critical weight and volume constraints of future systems that are designed for increased capability and agility, including all electric naval ships, unmanned (air, surface, subsurface, ground) vehicles, aircraft auxiliary power units, and man-portable power applications. Additionally, the fuel cells and fuel cell systems developed in this program will provide enhanced mission endurance, as well as reduced logistics support requirements through more efficient fuel utilization.

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The Office of Naval Research (ONR) Fuel Cell Program addresses technology gaps to enable fuel cell power systems that will meet the electrical power needs of future naval surface, subsurface, and air systems, as well as Marine Corps land-based and man portable system. These power generation systems have the potential to substantially reduce life cycle costs as a result of greater system efficiencies particularly under partial loading conditions. Their operational capability provides low audible noise and thermal signatures compared to other alternatives. In addition, this technology provides the potential for lower maintenance, lower costs, and lower emissions including SOx and NOx than other comparable power generation systems.



This program leverages knowledge gained through early technology demonstration efforts initiated under the ONR Ship Service Fuel Cell Program in the mid-1990s. The current program has expanded to develop systems for shipboard, portable power, unmanned vehicle, and mobile power applications, and includes a broad-based basic research component that feeds into applied programs addressing the unique aspects of the targeted Navy and Marine Corps systems and platforms.

An operating fuel cell system consists of the fuel cell stack where energy conversion occurs, as well as the fuel and oxidizer tanks, the fuel processing subsystem (desulfurization and reforming, when required), air management, and control and conditioning electronics. ONR Fuel Cell Program basic research efforts are focused on developing new experimental techniques to directly probe relevant physics and chemistry in high temperature fuel cells and new multi-scale theoretical methods that span 1st principles atomistic understanding and cell level designs. Applied research efforts emphasize modeling and simulation to optimize the design balance between system efficiency, complexity, and volume to meet operational and environmental requirements. These requirements include the ability to use logistics fuel, provide reliable and responsive quality power, to operate in environmental extremes, and to withstand shock and vibration, with minimal operational signature, size and weight. Component and systems development and demonstration are also conducted in the applied research program.

### Research Challenges and Opportunities:

- *New experimental methods to directly probe relevant physics and chemistry and new theoretical methods for multi-scale modeling and simulation that span 1st principles atomistic understanding and system level designs.*
- *Improved overall volumetric power density, modular system designs to reduce complexity, systems ruggedized for the naval environment, higher fuel preprocessing capability to remove sulfur and enable the use of multiple logistics fuels, enhanced catalyst structure and supports for system size reduction, enhanced reforming and hybrid air system technologies, and system life demonstrations.*
- *Development of modular, compact, high temperature fuel cell systems which provide highly efficient, silent power for vehicle and forward deployed operation. These systems will utilize JP-8 but must be compatible with future fuels, such as synthetic and desulfurized JP-8.*
- *Approaches to providing a refuelable, long endurance capability. The major challenge is the need to carry the oxidant as well as the fuel. Safe, high energy content fuels that are not currently in the logistics chain will be considered, with a long-term goal of using Navy logistics fuels.*
- *Approaches to providing single person portable power capability in the 500-1000 W range using JP-8 as the fuel to address the gap between batteries and current military tactical generators.*
- *Approaches to significantly improve the endurance of small, tactical UAVs, where size and power are key challenges.*

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